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GB 1360606 A WO 84/00611 A1

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(54) MRI magnet with axially adjustable Rose shim rings

(57) The Rose shim rings in a C type MRI magnet are axially retractable so that the head of a patient may be inserted easily into the magnet. The Rose rings may be moved by jacks or by threading and screwing. The ring positions may be monitored by use of a photoelectric microscope at three angular positions, and fine adjustment may be made using an array of at least 5 NMR probes. There may be more than one Rose shim ring on each pole.

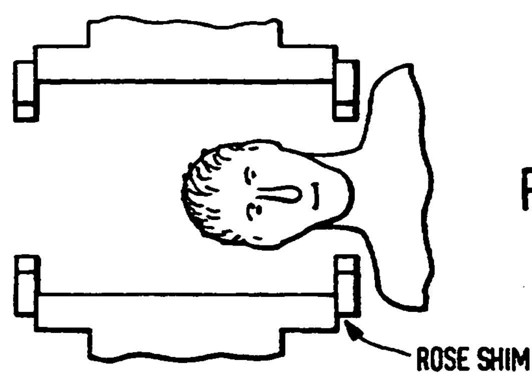

FIG. 3

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

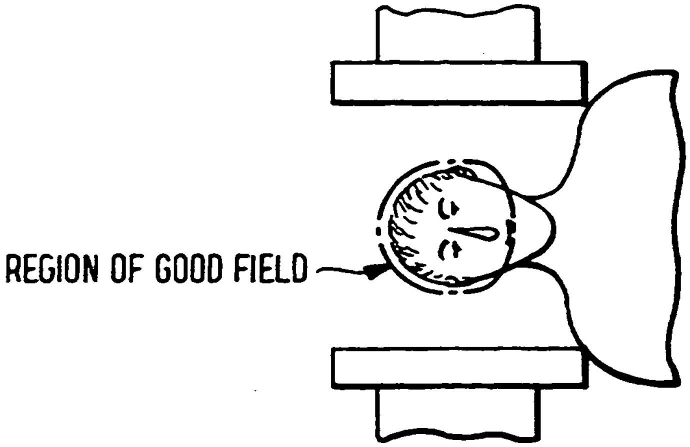

FIG. 1

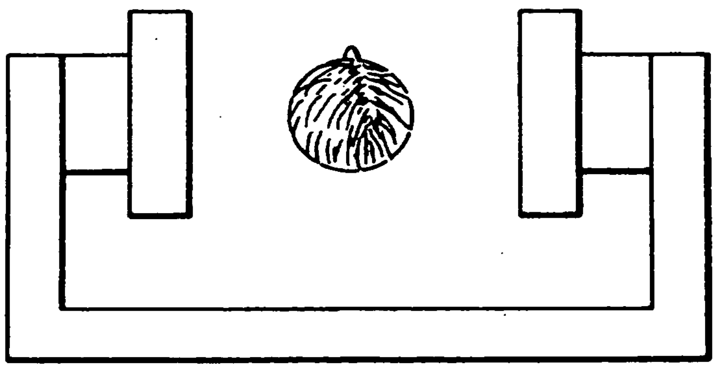

FIG. 2

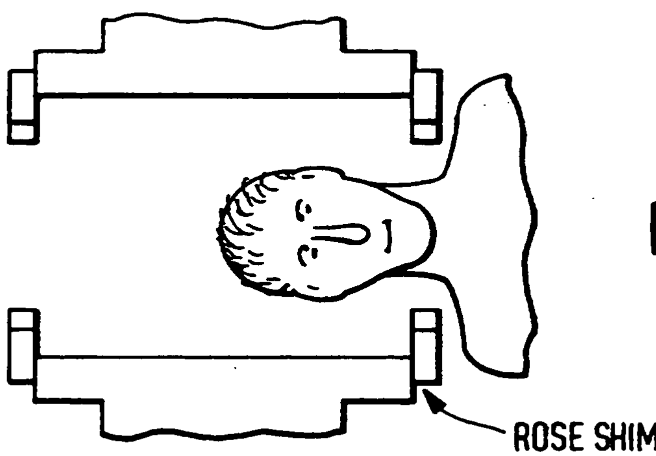

FIG. 3

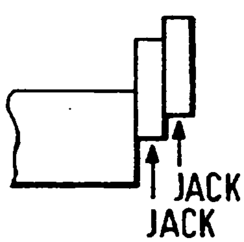

FIG. 4

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Nuclear Magnetic Resonance Imaging Apparatus

This invention relates to nuclear magnetic resonance imaging (MRI) apparatus and the problem of accessibility in relation to firstly the patient being inserted into the apparatus and secondly the problem of accessing the patient once inserted.

The general problem is best illustrated using "C" type magnets which may be used to establish the B_o magnetic field. The same principles can however be applied to any magnet structure.

Generally speaking, "C" type magnets are constructed by optimising design from some rough and ready guidelines. Thus, if the volume of good field is to have a diameter of n mm ($\pm$ 10 parts per million), the spacing between the poles has to be about 1.5 n or more, and the diameter of the poles about 3 n or more. This means that if the target is to image the brain of a patient, for which a volume of good field of 25 cm in diameter might be needed, the gap has to be around 37 cm, and the pole diameter 75 cm. The region of good field is located centrally in the poles, so that the combination of pole diameter and gap size means that a patient can lie with his/her head between the poles only as long as the main field is in the anterior/posterior direction, otherwise the poles obstruct the patients shoulders. However, because, with an anterior/posterior main field, the face is hidden between the poles, this is not a good arrangement clinically, where it is important in many, particularly interventional, studies to observe the patient's face, and have access to it for anaesthesia etc.

The better alternative is to have the field transverse to the patient, so that clinicians are able to look down on the patient's face. The problem is, as mentioned previously, that his/her shoulders get in the way of getting the head into the good region of field. In practice the gap is constrained to be 50 cm or more. In order to maintain field homogeneity, even if the same volume is specified, pole diameter must then be increased - to in the region of 1 metre or so. In order to generate the necessary flux at any specified field, more magnetomotive force (m.m.f.) is needed, and more iron included in the path. These make the structure bigger, and so push clinicians further away from the patient.

Figure 1 shows the ideal, but unrealistic situation, while Figure 2 shows another perspective of the same configuration. Figure 3 shows a feasible configuration of the magnet. The outer rim is well known as the "Rose Shim", and is conventionally used as an associated feature in improving homogeneity in this form of magnet. A Rose shim is a ring-shaped permanent magnet (typically iron) which is mounted concentrically with a pole of the magnet and which causes the region of good field to be moved towards the patient's head which is disposed to one side of the gap. Conventionally, the gap between the Rose shim faces determines patient access, and represents one of the limiting factors on magnet size and performance. A typical arrangement comprises a magnet with a gap of 240 mm, volume of good field of 160 mm DSV and 600 mm diameter poles. This means that the distance from the outside of the Rose shims to the edge of the good field along any diameter is 240 mm - or too far for anything except the top of the head of quite a large man to enter.

Bringing in the Rose shims (even with little refinement in the design) results in

a volume of good field which is close enough to the edge of the poles for the brains of very many people. Bringing in the shims further, and making them complex, i.e. multiple rings, as in Figure 4, brings the good field nearer the edge still.

The problem is that the gap between the Rose shim faces is now so small the patient cannot be inserted into the magnet, and removed from it, particularly in an emergency.

According to the present invention the shims are capable of being retracted and repositioned before and after patient positioning. This can be done by jacking (or threading, and screwing) the shims, and monitoring their positions using a photoelectric microscope at three angular positions, and an array of at least 5 NMR probes.

The photoelectric microscopes are used to reposition the shims as well as practical. Their bodies are mounted on the main poles and they detect scales on the shims rings. The NMR probes are used to make a final adjustment. They monitor field at positions, at least, along the X and Y axes (where Z is the direction of the main field) and the pole centre.

There is a set of measuring devices for each pole. More than one shim ring is needed if more than one body/head size is being catered for. In practice there has to be at least one additional ring for each additional final position of the shims. Note that the further in the shim rings are bought the nearer the region of good field comes to the edges of the poles. In this way small people can be accommodated as well as large ones.

CLAIMS

1. A magnetic resonance imaging apparatus of the kind having a main field magnet and so-called Rose shims associated with the poles of the magnet in order to improve the homogeneity of the magnet field, characterised in that there are means associated with the Rose shims to enable their positions with respect to the said magnet to be adjusted.

2. Apparatus as claimed in Claim in which the said adjusting means comprises a jack or jacks.

3. Apparatus as claimed in Claim 1 or 2 including a photoelectric microscope for monitoring the positions of the Rose shims to enable adjustments of the Rose shims to be made.

4. Apparatus as claimed in any previous claim including a plurality of nuclear magnetic resonance probes for accurately determining the positions of the Rose shims to enable final accurate adjustments of the positions of the Rose shims to be made.

5. Magnetic resource imaging apparatus substantially as hereinbefore described with reference to and as shown in Figures 3 or 4 of the accompanying drawings.

Amendments to the claims have been filed as follows

1. A magnetic resonance imaging apparatus of the kind having a main field magnet and so-called Rose shims associated with the poles of the magnet in order to improve the homogeneity of the magnet field, characterised in that there are means associated with the Rose shims to enable their positions with respect to the said magnet to be retracted to allow patient access.

2. Apparatus as claimed in Claim 1 in which the said adjusting means comprises a jack or jacks.

3. Apparatus as claimed in Claim 1 or 2 including a photoelectric microscope for monitoring the positions of the Rose shims to enable adjustments of the Rose shims to be made.

4. Apparatus as claimed in any previous claim including a plurality of nuclear magnetic resonance probes for accurately determining the positions of the Rose shims to enable final accurate adjustments of the positions of the Rose shims to be made.

5. Magnetic resonance imaging apparatus substantially as hereinbefore described with reference to and as shown in Figures 3 or 4 of the accompanying drawings.

6. A method of magnetic resonance imaging using a main field magnet and so-called Rose shims associated with the poles of the magnet in order to improve the

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homogeneity of the magnet field, in which the Rose Shims are retracted to allow patient access.

7. Apparatus as claimed in Claim 6 in which the said adjusting means comprises a jack or jacks.

8. Apparatus as claimed in Claim 6 or 7 including a photoelectric microscope for monitoring the positions of the Rose shims to enable adjustments of the Rose shims to be made.

9. Apparatus as claimed in any previous claim including a plurality of nuclear magnetic resonance probes for accurately determining the positions of the Rose shims to enable final accurate adjustments of the positions of the Rose shims to be made.

10. A method of magnetic resonance imaging substantially as hereinbefore described with reference to Figures 3 or 4 of the accompanying drawings.

The Patent Office

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Application No: GB 9704854.0
Claims searched: 1-5

Examiner: K. Sylvan
Date of search: 11 May 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G1N (NG38,NG38A,NG38B,NG38D)

Int Cl (Ed.6): G01R (33/38,33/383,33/3815,33/3873)

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 1360606	Parker. See the figures	-
X	WO 84/00611 A1	Oldendorf. See figure 4	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		

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